Philosophical Transactions

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& lettere Etruſche. Delle quali vi moſtrero io la copia à voſtro piacere, come à me la moſtrò & diede il dottiſſimo & parimente umaniſſimo Piero Vettori noſtro, diligentiſſimo inveſtigatore delle coſe antiche; inſieme con lo Alfabeto Etruſco, che all'ora non era fuori. De ſtatuis iſtis tranſcripta hæc eſſe volui, tum ut, me Auctore, inquirere non tardares, quorum forte in porticibus, aliiſve in locis admirandæ etiam nunc ſtant, tum præcipue ut ſcires, an forte Iconum, quas jam in magno ſatis numero poſſidet *R. Soc.* prototypi, capita ſua veneranda inter illas tollant. De hac re doctos quibuſcum per Italiam literarum commercium habes, ſpeciatim *Hetruſcos* & Umbros facile poteris percontari. Ex quibus, ſi quæ expectationi noſtræ reſpondeant acceperis, fac quæſo, ut ea quam primum cognoſcam. *Vale*, Vir optime, ac eruditiſſime, & redamare perge integerrimum tui cultorem *Hickeſium*. Faxit Deus, ut diutiſſime vivas doctorum omnium deliciæ, & bonarum literarum, is qui es, maximus ſemper adjutor, & patronus. Iterum *vale*.

IV. *The Theory of Muſick reduced to Arithmetical and Geometrical Proportions, by the Reverend Mr* Tho. Salmon.

SIR,

HAving had the honour laſt week of making the trial of a Muſical experiment before the Society at *Greſham College*, it may be neceſſary to give a farther account of it; that the Theory of Muſick, which is but little known in this Age, and the practice of it, which is arriv'd at a very great excellency, may be fixed upon the ſure foundations of Mathematical certainty. The Propoſitions, upon which the Experiment was admitted, were: That Muſick conſiſted

ed in Proportions, and the more exact the Proportions, the better the Muſick: That the Proportions offer'd were the ſame that the ancient *Grecians* us'd: That the Series of Notes and Half Notes was the ſame our Modern Muſick aim'd at: which was there exhibited upon finger-boards calculated in Mathematical proportion. This was demonſtrated upon a Viol, becauſe the Strings were of the greateſt length, and the proportions more eaſily diſcern'd; but may be accommodated to any Inſtrument, by ſuch mechanical contrivances as ſhall render thoſe ſounds, which the Muſick requires.

To prove the foregoing Propoſitions, two Viols were Mathematically ſet out, with a particular Fret for each String, that every Stop might be in a perfect exactneſs: Upon theſe, a Sonata was perform'd by thoſe two moſt eminent Violiſts, Mr *Frederick* and Mr *Chriſtian Steffkins*, Servants to her Majeſty; whereby it appear'd, that the Theory was certain, ſince all the Stops were owned by them, to be perfect. And that they might be prov'd agreeable to what the beſt Ear and the beſt Hand performs in Modern practice, the famous *Italian*, Signior *Gaſperini*, plaid another Sonata upon the Violin in Conſort with them, wherein the moſt compleat Harmony was heard.

The full knowledge and proof of this Experiment may be found in the two following Schemes, wherein Muſick is ſet forth, firſt Arithmetically and then Geometrically: The Mathematician may, by caſting up the proportions, be ſatisfied, that the five ſorts of Half-Notes here ſet down, do exactly conſtitute all thoſe intervals, of which our Muſick does conſiſt. And afterwards he may ſee them ſet forth upon a Monochord, where the meaſure of all the Notes and Half-Notes comes exactly to the middle of the String. The Learned will find that theſe are the very proportions which the old *Greek* Authors have left us in their Writings, and the Practical Muſician will teſtifie, that theſe are the beſt Notes he ever heard.

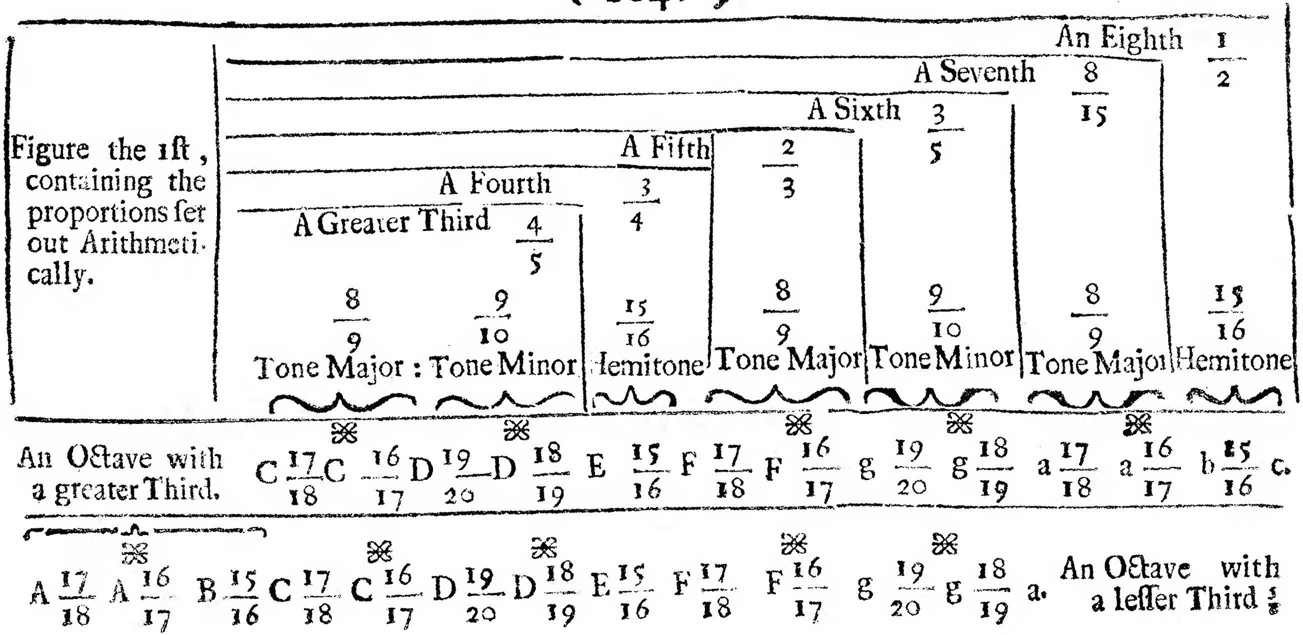

Figure the 1ſt, containing the proportions ſet out Arithmetically.

An Eighth 1/2
A Seventh 8/15
A Sixth 3/5
A Fifth 2/3
A Fourth 3/4
A Greater Third 4/5
8/9 Tone Major : 9/10 Tone Minor
15/16 Hemitone
8/9 Tone Major
9/10 Tone Minor
8/9 Tone Major
15/16 Hemitone
An Octave with a greater Third.
C 17/18 C 16/17 D 19/20 D 18/19 E 15/16 F 17/18 F 16/17 g 19/20 g 18/19 a 17/18 a 16/17 b 15/16 c.
A 17/18 A 16/17 B 15/16 C 17/18 C 16/17 D 19/20 D 18/19 E 15/16 F 17/18 F 16/17 g 19/20 g 18/19 a.
An Octave with a leſſer Third.

The Explication of the firſt Figure.

Between the two loweſt Lines, you have the Series of all the 12 half Notes in an Octave, from Are to Alamire, which added together make an Octave or exact Duple Proportion: The ſeveral parts alſo added together make all thoſe intervals of which it is conſtituted. As for example, the two half Notes from A to A✻ $\frac{17}{18}$, and from A✻ to B $\frac{6}{17}$ make a Major Tone $\frac{8}{9}$; to which if an Hemitone from B to C $\frac{15}{16}$ be added, you have a leſſer Third $\frac{5}{6}$.

In like manner between the two next lines, you have the ſeries of all the 12 half Notes, in an Octave from C fa ut to C ſol fa ut: the two firſt Tones added together make a greater Third: and ſo you may add a Tone or Hemitone till you arrive at every interval in the Octave, which ſo call'd becauſe eight ſounds are required for expreſſing thoſe ſeven gradual ſteps whereby we commonly aſcend to it.

It may be alſo obſerv'd, that the proportions falling upon the ſame Notes in two Keys, one finger-board will be ſufficient for both.

'TIs acknowledg'd by all that are acquainted either with Speculative or Practical Muſick, that every interval is divided into two parts, whereof one is greater than the other: An Eighth $\frac{1}{2}$ into a Fifth $\frac{2}{3}$ and a Fourth $\frac{}{4}$. Again, a Fifth $\frac{2}{3}$ into a greater Third $\frac{4}{5}$ and a leſſer Third $\frac{5}{6}$. Thus alſo a greater Third $\frac{4}{5}$ muſt be divided into a Tone Major $\frac{8}{9}$ and a Tone Minor $\frac{9}{10}$. The Leſſer Third (to comply with the practice of Muſick) is rather compounded of, than divided into a Tone Major $\frac{8}{9}$ and an Hemitone, which is its complement, $\frac{15}{16}$.

Three Tones Major, two Tones Minor, and two of the foreſaid Hemitones, placed in the order found in the Scheme, exactly conſtitute the practical Octave; which is ſo call'd becauſe it conſiſts of eight ſounds, that contain the ſeven gradual intervals. But it is alſo neceſſary to ſet down the Diviſions of the whole Tones, which are the true Chromatick half Notes, becauſe there is great uſe of them in Practical Muſick.

To make all our whole Notes, and all our half Notes of an equal ſize, by falſifying the proportions, and bearing with their imperfections, as the common practice is, may be allow'd by ſuch Ears as are vitiated by long cuſtome: But it certainly deprives us of that ſatisfactory pleaſure which ariſes from the exactneſs of ſonorous numbers; which we ſhould enjoy, if all the Notes were truly given according to the Proportions here aſſign'd.

It is very eaſie to ſatisfie our ſelves in the Arithmetical Scheme, by thoſe operations which *Gaſſendus* has ſet down in his Manuduction to the Theory of Muſick, Tom. V. pag. 635. As for example, his rule for Addition is, That two Proportions being given, if the Greater number of one be multiplied by the Greater number of the other, and the Leſſer by the Leſſer, the two numbers produc'd exhibit the compounded Proportions. Thus take a Practical Fifth $\frac{2}{3}$ and a Practical Fourth $\frac{3}{4}$ for the two Proportions given, multiply 3 by 4 and you have 12, then multiply 2 by 3 and you have 6: which compounded proportion of 12 to 6 makes the Practical Octave $\frac{1}{2}$.

Thus, according to his Arithmetical operations of Addition, Subſtraction, Multiplication or Continuation, and Diviſion, is our whole Syſtem proved, which for the more eaſie application to Practical Muſick, ſhall be alſo ſet forth Geometrically upon the 6 ſtrings of a Viol. *See Figure the 2d.*

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This Mathematical fixing of the Frets enables every Practitioner, who ſtops cloſe to them, to give the Proportions of the Notes in a greater exactneſs, than can be done upon the Baſs-Violin or Violin itſelf: ſince they may be ſet forth more perfectly by a pair of Compaſſes dividing a line, than the niceſt Ear can direct.

Though the Frets for the ſeveral Strings do not ſtand in a ſtrait line, and the places are alſo ſhifted in different Keys, yet the Ear naturally directs the Fingers to them: inſomuch that thoſe perſons, who have all their lives time been accuſtom'd to ſtop upon Frets that go quite croſs the Finger-boards of their Inſtruments, do with very little practice fall right upon theſe. Such is the power of a Muſical Genius, as may be undeniably proved by thoſe that play upon the Violin; who, when they change the Key, fall upon the right Stops, tho' they have no viſible direction where to ſtop, nor time to alter, by the Ear, the Note they firſt pitched upon.

By this Standard of Regular Proportions may the Voice be formed to ſing the pureſt Notes; they are all the ſame in Vocal and Inſtrumental Muſick; if then the Inſtrument which governs the Voice be perfect, the Ear will of neceſſity bring it to perfection. It is a great pity that a good natural Voice ſhould be taught to ſing out of Tune, as it muſt do, if it be guided by an imperfect Inſtrument; and this may be the reaſon why ſo few attain to that melody, which is ſo much valued; but ſince we now know wherein perfection lies, a conſtant practice will come to the attainment of it. The dividing Wholes into Chromatick Hemitones is very neceſſary, but very difficult for the Voice to be broken to: If it learns from an Inſtrument whoſe whole Notes and whoſe half Notes are ſuppoſed to be equal, the ſound muſt needs be very uncertain and unharmonical; whereas the proportions truly fixed, wou'd bring it to a perfection in the niceſt and moſt charming part of Muſick.

The Chromatick Hemitones are the ſmalleſt Intervals our Modern Muſick aims at, tho' the Ancients had their Enharmonick quarter Notes, which they eſteem'd their greateſt excellency: Theſe may alſo in time be recover'd, ſince we know their proportions; for as the Diatonick Tone is divided into Chromatick Hemitones, ſo after the ſame manner may the Chromatick Hemitones be divided into thoſe leaſt Enharmonick Intervals, which were ever made uſe of.

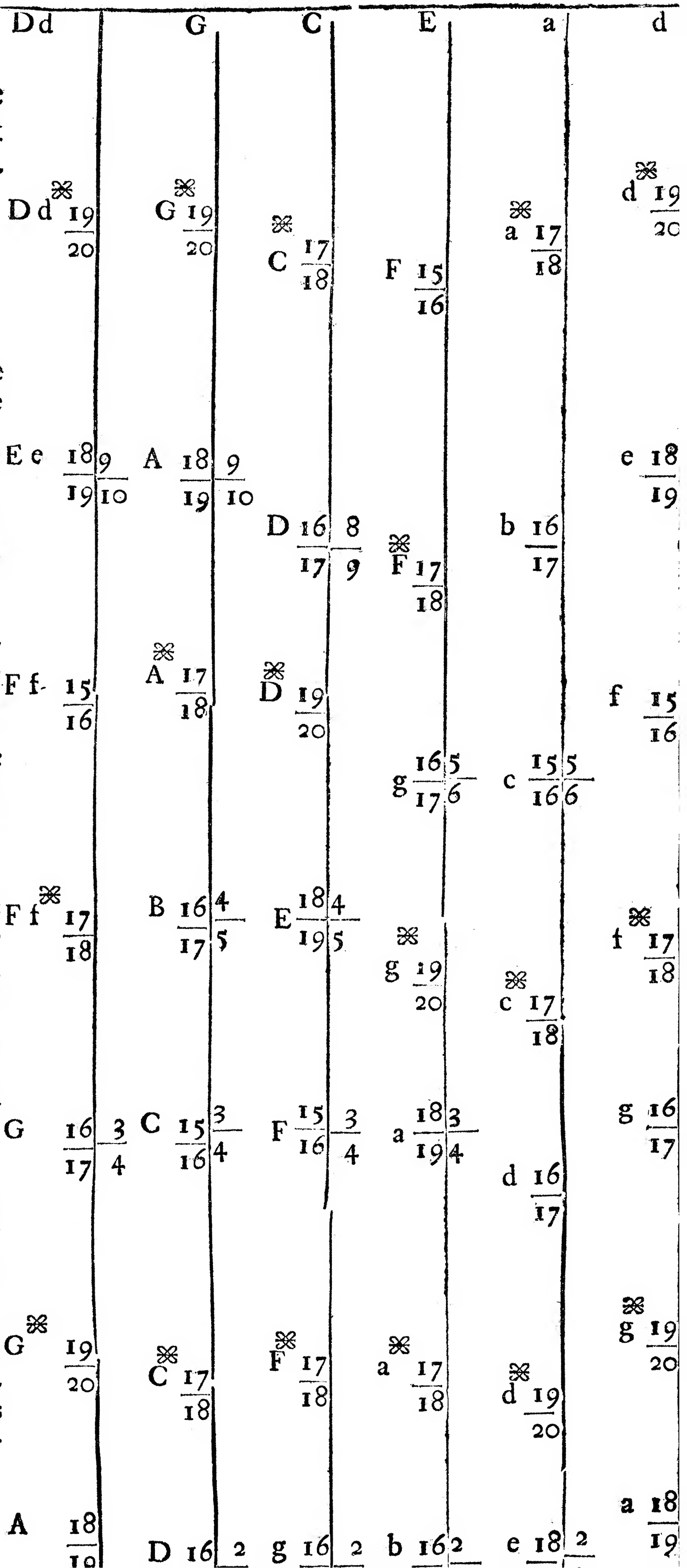
But if we go no further, yet this Experiment demonſtrates the true Theory of Muſick, and brings the practice of it to the greateſt perfection.

V. *Part of a Letter from the late Sir* Philip Skippon, *Kt, to the late Reverend Mr* John Ray, *concerning the Bones of a* Humane Fœtus *voided thro' an Impoſtume in the Groin. Communicated to the Publiſher, by Mr* Samuel Dale.

London, January 22. 1662.

YEſterday in the Afternnon my Cozen *Horſnel* and my ſelf viſited a Woman 66 years old, in *Drury-lane*, who had a Child conſumed in her *Uterus* about 28 years ago; She bore two Children after this, one lived 11 years, and the other 6. About 8 years ago an *Impoſtume* broke out in the Right *Inguen*, and then ſeveral Bones of a Dead Child were expell'd, (ſome of them I have by me.) She hath a great Swelling now in that *Groin*, where ſhe feels ſomewhat very hard, which ſhe ſuſpects are Bones. I took a particular account of all Circumſtances; but this is proportionable to the narrow extent of a Letter, and indeed is the ſubſtance of all.

The 2d Figure, wherein the Proportions of Muſick are deſcribed Geometrically.



The Explication.

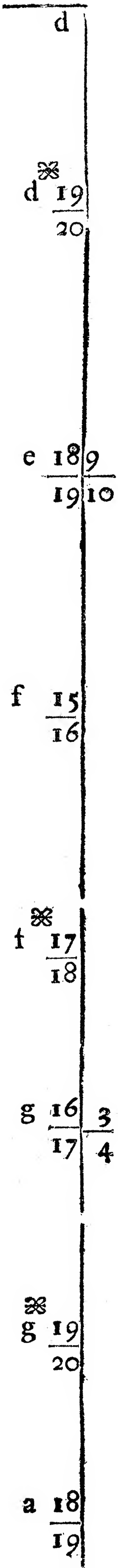
These ſix lines repreſent the ſix Strings of the Viol in the common Tuning.

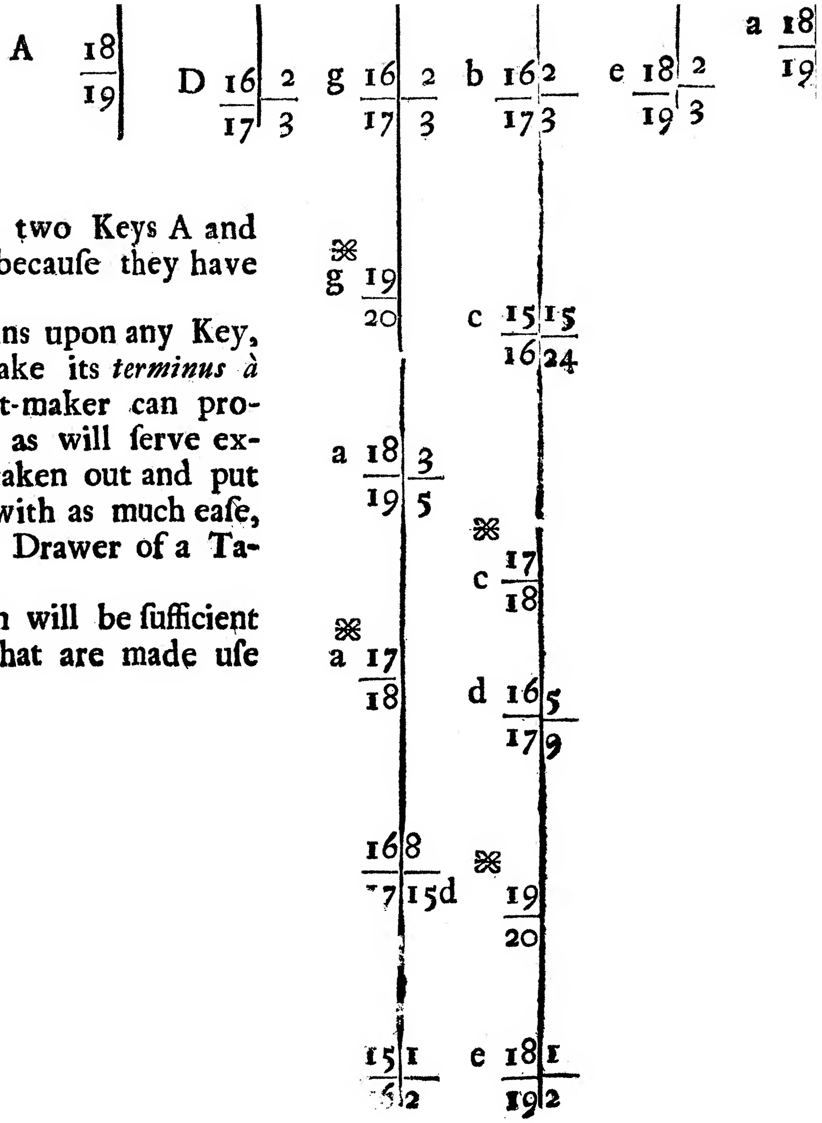
The ſounding part of each String from the Nut to the Bridge is ſuppos'd to be 30 inches long; the two middle Strings C and E are drawn out to 15 inches, the half of the whole.

'Tis eaſie to meaſure every interval with a pair of Compaſſes. Suppoſe you are to take the 20th part of the String G; 'tis an inch and a half for the firſt half Note: If you take the whole Note from G to A, 'tis the tenth part, and muſt be 3 inches.

After theſe are taken away, your String will be but 27 inches long, ſo that if you advance one Note, or a Major Tone further, you muſt take a 9th part of it, which will be 3 inches more, whereby you arrive at a greater Third, being the fifth part of the whole String. Thus the ſeries of all the Notes may be demonſtrated.

All the Strings are Uniſon at the ſtops where the tuning requires: So that though the Proportions be carried on as far as the frets allow, yet the ſtring is open the ſame with the ſtop of that ſtring to which it is tuned; and accordingly the ſeries of the Notes proceeds as if they were all upon a Monochord.


d
d※ 19/20
e 18/19 9/10
f 15/16
f※ 17/18
g 16/17 3/4
g※ 19/20
a 18/19



This Calculation ſerves but for two Keys A and C, which are called Natural, becauſe they have no eſſential flats or ſharps.

But becauſe the Compoſer begins upon any Key, and the ſeries of Notes muſt take its *terminus à quo* from thence; the Inſtrument-maker can provide ſuch movable Finger-boards as will ſerve exactly for every Key. They are taken out and put in upon the Neck of the Viol, with as much eaſe, as you pull out and thruſt in the Drawer of a Table.

Three, or at moſt five of them will be ſufficient to accommodate all the Keys that are made uſe of.

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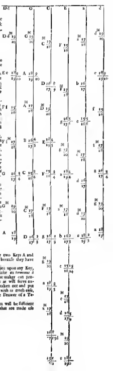

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